FEB 17 2004
PATENT & TRADEMARK OFFICE
USPTO

EMPLOYEE

NAME	DEPT	MGRID	SALARY	BONUS

(C1) NAME $\neq$ NULL

(C2) DEPT = "US*"

(C3) BONUS $\leq$ 0.4 x SALARY

(C4) FOREIGN KEY (DEPT, MGRID)
REFRENCES MANAGER (DEPT, MGRID)

(C5) (DEPT = "USSales") $\Rightarrow$ SALARY $\leq$ MGR (DEPT, MGRID).SALARY

EMPLOYEE

NAME	DEPT	MGRID	SALARY

(C6) NAME $\neq$ NULL

(C7) DEPT = "US*"

(C8) 500 $\leq$ MGRID $\leq$ 999

(C9) 100000 $\leq$ SALARY $\leq$ 200000

FIG.1

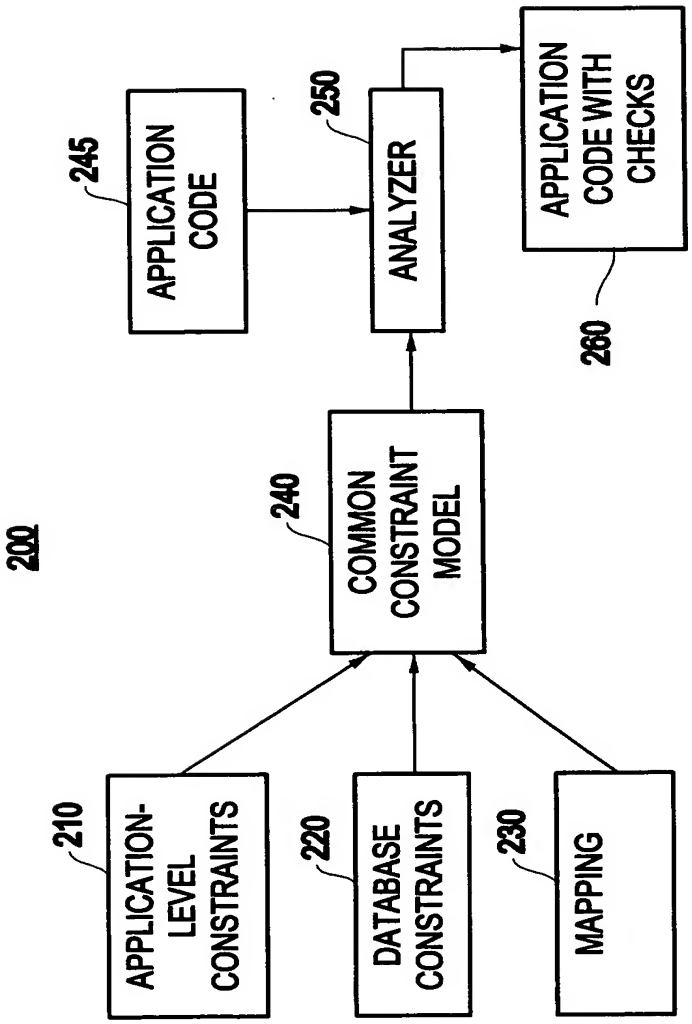
200
210
APPLICATION-LEVEL CONSTRAINTS
220
DATABASE CONSTRAINTS
230
MAPPING
240
COMMON CONSTRAINT MODEL
245
APPLICATION CODE
250
ANALYZER
260
APPLICATION CODE WITH CHECKS

FIG.2

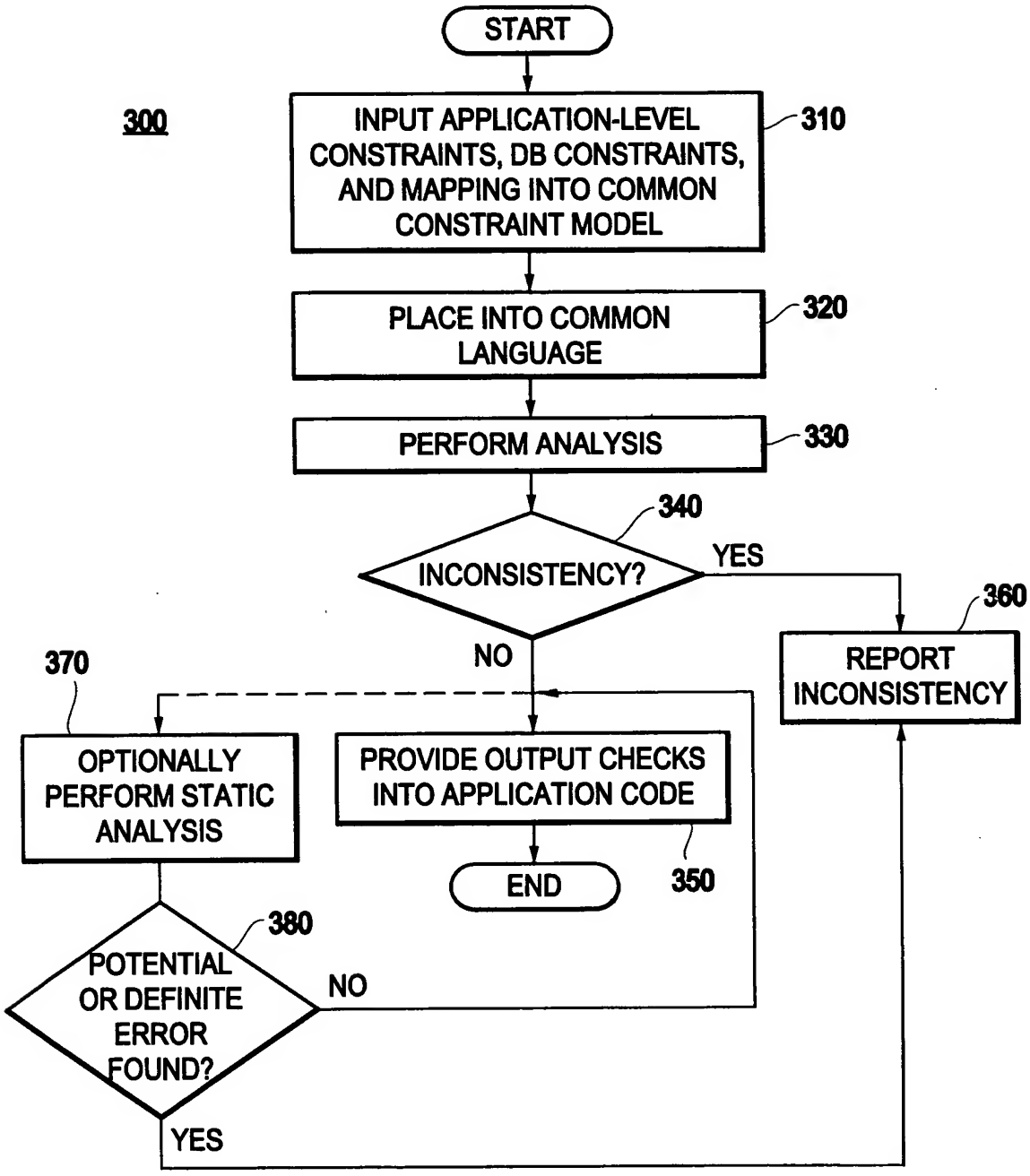
START
300
INPUT APPLICATION-LEVEL CONSTRAINTS, DB CONSTRAINTS, AND MAPPING INTO COMMON CONSTRAINT MODEL
310
PLACE INTO COMMON LANGUAGE
320
PERFORM ANALYSIS
330
340
INCONSISTENCY?
YES
360
REPORT INCONSISTENCY
NO
370
OPTIONALLY PERFORM STATIC ANALYSIS
PROVIDE OUTPUT CHECKS INTO APPLICATION CODE
END
350
380
POTENTIAL OR DEFINITE ERROR FOUND?
NO
YES

FIG.3

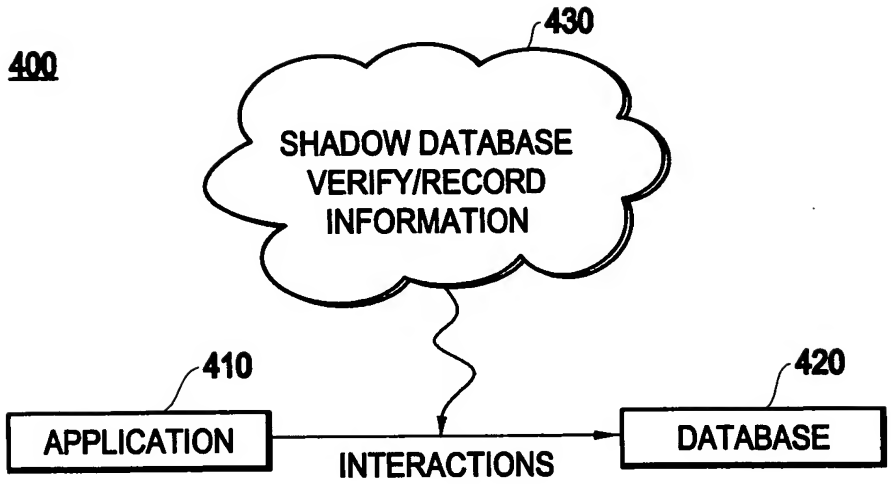
400
430
SHADOW DATABASE
VERIFY/RECORD
INFORMATION
410
APPLICATION
INTERACTIONS
420
DATABASE

FIG.4

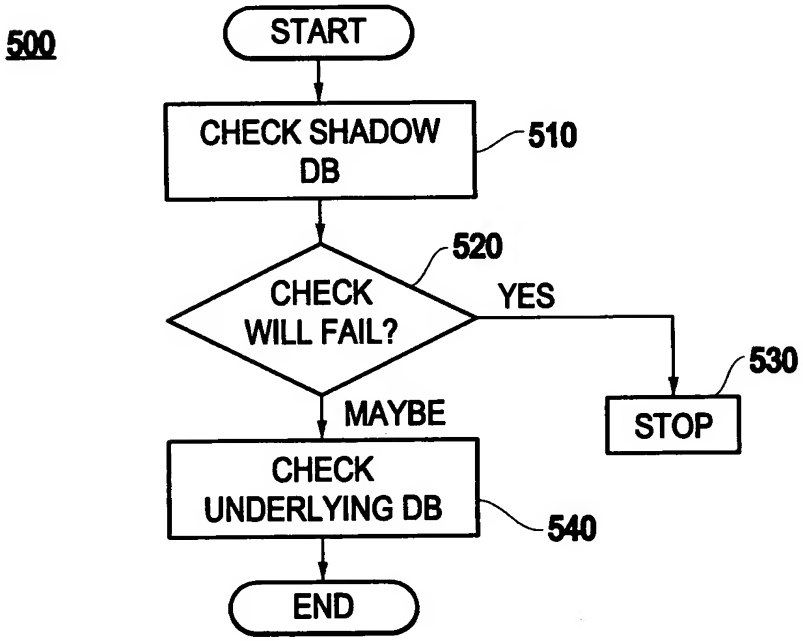
500
START
CHECK SHADOW
DB
510
520
CHECK
WILL FAIL?
YES
530
STOP
MAYBE
CHECK
UNDERLYING DB
540
END

FIG.5

```
DISCONNECT ALL;
DROP DB FOO1;
CREATE DB FOO1;
CONNECT TO FOO1;

CREATE TABLE ODED.DCODES(
C CHARACTER(1) NOT NULL,
CHECK(
 (C = 'A') OR (C = 'B') OR (C = 'C') OR
 (C = 'D') OR (C = 'E')),
PRIMARY KEY (C)
);


CREATE TABLE ODED.CUSTOMER(
CUSTOMERID BIGINT NOT NULL,
NAME CHARACTER(20) NOT NULL,
CHECK (
 ( (CUSTOMERID >= 100000) AND
 (CUSTOMERID <= 200000)) OR (
 (CUSTOMERID >=20000000) AND
 (CUSTOMERID <= 40000000) ) ),
PRIMARY KEY (CUSTOMERID) );


ALTER TABLE ODED.CUSTOMER DATA
CAPTURE CHANGES NOT VOLATILE;



CREATE TABLE ODED.DISCOUNT(
DISCOUNTCODE CHARACTER(1) NOT NULL,
PERCENT INTEGER NOT NULL,
DELAY INTEGER NOT NULL,
CUSTID BIGINT NOT NULL,
-- CHECK (
--  (AMOUNT > 1) AND (AMOUNT <= 100000) ),
-- CHECK ( (ORDERNUM >= 0) AND (ORDERNUM
<= 10000000)),
CHECK(
 ( (1 <= DELAY) AND (DELAY <=7) ) OR ( (10
<= DELAY) AND (DELAY <= 30) ) OR ( (45 <=
DELAY) AND (DELAY <= 60) ) ),
CHECK(PERCENT in (5, 10, 15) OR ( (20
<= PERCENT) AND (PERCENT <= 30) ) ),
CHECK(DISCOUNTCODE in ('A',
'B', 'C', 'D', 'E') ),
PRIMARY KEY (CUSTID, DISCOUNTCODE),
FOREIGN KEY (CUSTID) REFERENCES
ODED.CUSTOMER (CUSTOMERID) ON DELETE
CASCADE,
FOREIGN KEY (DISCOUNTCODE)
REFERENCES
ODED.DCODES (C)
);

ALTER TABLE ODED.DISCOUNT DATA
CAPTURE CHANGES NOT VOLATILE ;

CREATE TABLE ODED.INVENTORY(
ITEMNUMBER CHARACTER(8) NOT NULL,
AMTINSTOCK INTEGER NOT NULL,
CATEGORY VARCHAR(20) NOT NULL,
CHECK (
 (AMTINSTOCK >= 0) AND (AMTINSTOCK
<= 10000) ),
CHECK (
 ( ( ITEMNUMBER Like 'EU%') AND
 ( ITEMNUMBER > 'EU000000') AND
 ( ITEMNUMBER < 'EU999999') ) OR
 ( ( ITEMNUMBER Like 'US%') AND
 ( ITEMNUMBER > 'US000000') AND
 ( ITEMNUMBER < 'US999999') ) OR
 ( ( ITEMNUMBER Like 'WL%') AND
 ( ITEMNUMBER > 'WL000000') AND
 ( ITEMNUMBER , 'WL999999') )
),
PRIMARY KEY (ITEMNUMBER) );

ALTER TABLE ODED.INVENTORY DATA
CAPTURE CHANGES NOT VOLATILE;

CREATE TABLE
ODED.CUSTOMERCATEGORIES
CUSTOMERID BIGINT NOT NULL,
CATEGORY VARCHAR(20) NOT NULL,
-- CHECK (
-- (AMTINSTOCK >= 0) AND (AMTINSTOCK
<= 10000) ),
PRIMARY KEY (CUSTOMERID, CATEGORY),
FOREIGN KEY (CUSTOMERID) REFERENCES
ODED.CUSTOMER (CUSTOMERID) ON DELETE
CASCADE
 );

ALTER TABLE ODED.INVENTORY DATA
CAPTURE CHANGES NOT VOLATILE ;

CREATE TABLE ODED.ORDER (
ORDERNUM BIGINT NOT NULL,
CUSTID BIGINT NOT NULL,
AMOUNT DECIMAL NOT NULL,
TAX DECIMAL NOT NULL,
DISCOUNTCODE CHARACTER(1) NOT NULL
```

FIG.6A

```
CHECK ( (AMOUNT > 1) AND (AMOUNT <=
100000) ),
CHECK ( (ORDERNUM >= 0) AND (ORDERNUM <=
10000000) ),
CHECK ( (TAX <= .4 * AMOUNT) AND ( (TAX =
25) OR (TAX = 50) OR (TAX >= 100) ) ),
PRIMARY KEY (ORDERNUM),
FOREIGN KEY (CUSTID) REFERENCES
ODED.CUSTOMER (CUSTOMERID) ON DELETE
CASCADE,
FOREIGN KEY (DISCOUNTCODE) REFERENCES
ODED.DCODES (C)
);

ALTER TABLE ODED.ORDER DATA CAPTURE
CHANGES NOT VOLATILE;


CREATE TABLE ODED.ORDERDETAILS(
ORDERNUM BIGINT NOT NULL,
ITEM# CHARACTER(8) NOT NULL,
NOITEMSREQUESTED INTEGER NOT NULL,
NOITEMSSHIPPED INTEGER NOT NULL,
NOITEMSRECEIVED INTEGER NOT NULL,
CHECK ( (NOITEMSREQUESTED > 0) AND
 (NOITEMSREQUESTED < 101) ),
CHECK (NOITEMSRECEIVED <=
NOITEMSSHIPPED),
CHECK(NOITEMSSHIPPED <=
NOITEMSREQUESTED),
PRIMARY KEY (ORDERNUM, ITEM#),
FOREIGN KEY (ITEM#) REFERENCES
ODED.INVENTORY (ITEMNUMBER) ON DELETE
CASCADE,
FOREIGN KEY (ORDERNUM) REFERENCES
ODED.ORDER (ORDERNUM) ON DELETE CASCADE
);

ALTER TABLE ODED.ORDERDETAILS DATA
CAPTURE CHANGES NOT VOLATILE;

 CREATE TRIGGER CatTrigger
    AFTER INSERT ON
ODED.CUSTOMERCATEGORIES
   REFERENCING NEW AS xxx
   FOR EACH ROW MODE DB2SQL
   WHEN (NOT EXISTS
    (SELECT * FROM ODED.INVENTORY
     WHERE
xxx.CATEGORY=ODED.INVENTORY.CATEGORY
     ) )
                SIGNAL SQLSTATE '7599
('Cannot insert category field ')


CREATE TRIGGER InvTrig1
    AFTER DELETE ON ODED.INVENT
    REFERENCING OLD AS xxx
    FOR EACH ROW MODE DB2SQL
    WHEN (EXISTS
     (SELECT * FROM
ODED.CUSTOMERCATEGORIES
      WHERE
xxx.CATEGORY=ODED.CUSTOMERCATEGORIES.
CATEGORY
          ) )
              SIGNAL SQLSTATE '7600
 ('Cannot delete referenced category field ')

 insert into ODED.INVENTORY
values ('EU123456', 10, 'grinders')
```

FIG.6B

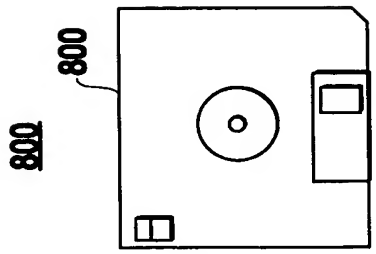
800
800

FIG.8

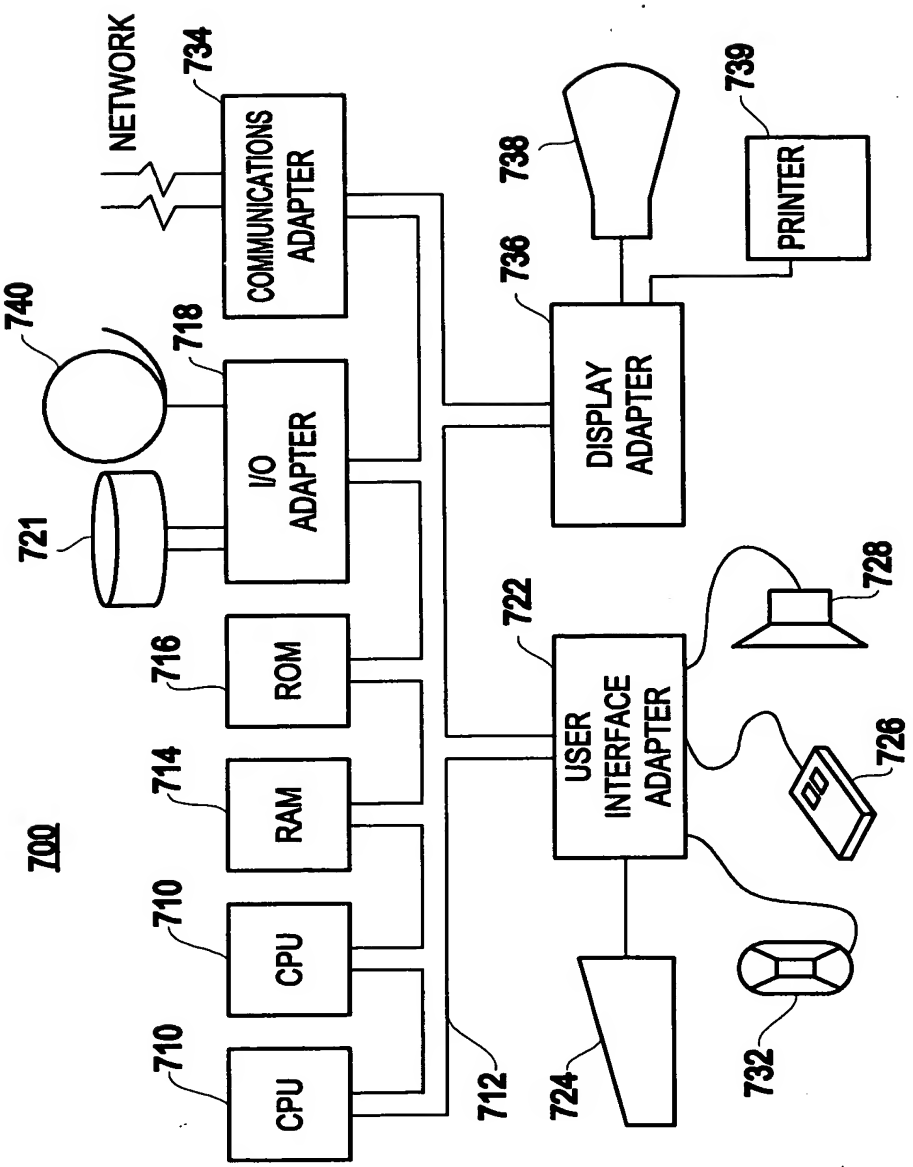
700
CPU
710
CPU
710
RAM
714
ROM
716
I/O ADAPTER
718
COMMUNICATIONS ADAPTER
734
NETWORK
DISPLAY ADAPTER
736
USER INTERFACE ADAPTER
722
PRINTER
739
738
740
721
712
724
732
726
728

FIG.7